



Missouri Produce Growers Bulletin

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Group GAP or Make a Group to do GAPs?

By James Quinn and Patricia Miller

A number of growers near produce auctions are expressing interest in getting GAPs certified. A grower can do this on their own or partner with some other growers. The experience at Rich Hill is that if a community works together beforehand, it makes it easier. There is a formal way to do this, using the GroupGAP process (discussed in a sidebar of the January MPG Bulletin issue). Another option is to work with several growers to be audited at the same time. This past year growers in Rich Hill did both these options, so this article is to review their experience, with as much detail on the process and cost as possible. For the 2016 growing season, about 30 growers were GAPs certified in the Rich Hill area.

Let's first consider organizing a few growers to get audited at the same time, as it is simpler. That is one advantage. These growers don't need to grow similar crops or market in a similar fashion; both of which may be required for GroupGAP. One needs to be harvesting a crop or crops to be audited. So that may complicate things if growers using greenhouses want to get audited early in the season and they partner with field growers. The driving reason to organize a small group is cost savings, and an inspector can do 3 or 4 growers in one trip.

Last year 8 growers in the Rich Hill were inspected this way. It took the auditor 2 trips to accomplish these audits. The average cost per grower was about \$300 (in 2014 it was \$370). One individual called the auditor and arranged the date and time. The cost of mileage for the auditor was averaged evenly across those audited for the day and he drove about 1½ hours each way. The growers were charged differently if the auditor had to spend more time at their farm. The growers were billed individually for the audit and there were 4 to 5 per day. They had worked with the USDA before so chose to work with them again; although they didn't know for sure which auditor they'd get, thought they'd get the same as before. They'd found him positive to work with. [Another company for auditing has been used in the past. Several negatives were cited: tended to switch inspectors around, auditors had less 'common sense', and an expectation for farms to be 'one size fits all'].

(continued on pg. 2)

Editor's note.

Missouri's weather can be both erratic and extreme. In addition to threats of high wind, hail, and sudden cold is also unprecedented rainfall. This occurred several times this spring around Missouri, in a number of places. With heavy rains can come flooding, which is generally devastating. Sometimes produce that is in good condition may seem worth salvaging. And if early enough in the season, planting another crop may seem worth pursuing. Unfortunately whether this can be done, from a food safety standpoint, must be considered for a commercial grower.

The center four pages of this newsletter walks one through all the considerations on this matter (Frequently Asked Questions About Handling Flooded Produce). There are probably some aspects of interest, whether or not flooding is likely to occur on your farm. One thing I took away, flooding from a creek or river is much more problematic than if it is temporary pooled water within a field (e.g. brief ponding).



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Group GAP or Make a Group to do GAPs? continued.

None of the growers required a 2nd visit, but it is in the contract that the auditor can do an unannounced visit at any time (which would include a charge). All the growers certified in 2016 were planning to repeat in 2017 and they used the same company for their water testing (Midwest Labs in Omaha, NE).

The primary advantage cited for this arrangement (versus GroupGap) was increased marketing options and ability to take your product to whatever buyer might be interested. Another benefit was feeling more confident about their operation, through the process by engaging directly with auditor (learning some things) and knowing they would pass or fail or their own, not be dependent upon others to also get things right.

The GroupGAP process at Rich Hill is organized by Good Natured Family Farms (see sidebar) This company provided the 'internal auditor' for the Rich Hill Farm Group. One grower was selected from the Rich Hill Farm Group to work with Good Natured and the GroupGAP process. The internal auditor visited each of the 18 Rich Hill GroupGAP farms and it took four partial days. In addition, the internal auditor had previously conducted training for the Rich Hill growers. The internal auditor is not compensated directly, rather Good Natured collects a marketing fee for any sales it organizes. [Growers are responsible to pack their product and purchase their own boxes or containers when marketing through Good Natured.]

Good Natured contacted the USDA auditor to arrange for his visit and it was the same USDA auditor as discussed earlier. Good Natured paid for all of the USDA fees or expenses. The 'group' passed on the first visit, so no follow up visit was required. These growers all used the same company for water testing (Midwest Labs in Omaha, NE). A 'Mock Recall' was conducted that growing season and Good Natured organized it.

All the growers in this GroupGAP are planning on certifying again in 2017, and additional growers are expected to join. GroupGAP facilitated 'growers learning from growers', but the primary reason cited for using it was being cheaper. [Since a marketing fee pays for the expenses, and it covers additional benefits (like customer access) the Rich Hill growers could not estimate what their actual 'cost' was.]

Helpful Comments Provided by Good Natured Family Farm*

Diana Endicott was kind enough to provide information to determine the average cost per grower and to expand on the process. Diana is one of the company's founders and serves as an internal auditor**.

The average cost was \$230. There were 21 farms, 18 in Missouri and 3 in Kansas, as part of the GroupGAP. The total cost was \$4800 that breaks down as \$2,000 for the USDA final audit, \$2300 for the Quality Management System audit, and \$500 for the Good Natured internal auditor time and travel. The Quality Management System audit was also conducted by the USDA and is required***. It helped make the final audit of six farms go faster.

Diana expects that both USDA audits will cost less for 2017, for two reasons. Recertifying farms will take less time and more growers will likely be certified, spreading out the costs. Diana felt a GroupGAP of about 30 was optimal to manage and spread the costs. GroupGAP has its challenges and their company's experience was a big help. They started a pilot program of GroupGAP and Rich Hill growers back in 2012, being financial assisted by the Wallace Center. She noted that some aspects of the Quality Management System might only be practical if using telephone and computer.

* Good Natured Family Farms is a marketing company of an alliance of over 100 family farms and small businesses. Those allied are stewards of the land who raise their animals humanely and care for the earth in a sustainable fashion (from <http://www.goodnaturedfamilyfarms.com>).

** An internal auditor has to receive specific training from the USDA.

*** The GroupGAP certification program requires that all Groups write and implement a Quality Management System based on an international industry quality standard. This standard is based on quality management principles that include the following: strong customer focus, management commitment and involvement, a process-based approach and continuous improvement.

Missouri Tomato School, scheduled for August 14-15, 2017, in Joplin

The School will include a day of educational sessions, followed by a half day of farm tours to innovative tomato producers. The keynote presenter will be Dr. Rick Snyder, nationally recognized greenhouse tomato specialist and host of the Mississippi Greenhouse Tomato Shortcourse for over 20 years. The educational sessions will bring together subject matter experts to cover all aspects of field and high tunnel/greenhouse tomato production, with an emphasis on sustainable practices. The cost of the workshop is \$30, which includes lunch on the first day and all educational resources. Check the Webb City Farmers Market website <http://www.webbcityfarmersmarket.com/grower-training.html> for updated information on the Missouri Tomato School. For additional information, or a mailed registration form, contact Patrick Byers at MU Extension-Webster County, 800 South Marshall Street, Marshfield, MO 65706; or telephone 417-859-2044.

Frequently Asked Questions About Handling Flooded Produce

The information in this document reflects our best effort to interpret federal food safety guidance and related scientific research, and to translate this into practical management options. However, growers are fully responsible for their own management decisions, for the quality and safety of the food they sell, and for compliance with all applicable laws and regulations.

Where the FDA stance is clear

1. **Does flooded produce have to be discarded? Yes,** if the edible portion has come in contact with flood waters the produce must be discarded due to the high risk of contamination from chemicals and microbial pathogens in flood water.
2. **My field of carrots/potatoes/parsnips/other root crop is still young and several months from harvest, can I sell the crop? No.** The FDA is clear that any edible portion of a crop that comes in contact with flood water may not be sold, even if you leave it in the ground afterwards for a long time. There is evidence that potatoes can uptake pathogens through their lenticels and carrots can take them up through their crowns.
3. **I had a planting of leafy greens (lettuces, spinach, Swiss chard, etc.) that did not germinate before the flood but now that the waters have receded it has emerged and looks great. Can I sell it? No,** this is a high risk. As they grow, the leaves will be in contact with flooded soil as this crop grows and thus could get contaminated with soil-borne chemical and/or microbial contaminants such as E. coli, Salmonella, etc. from wastes that were in flood water. Once attached, washing even with disinfectants cannot remove the pathogens.
4. **Can I peel and/or cook flooded produce (particularly root crops and winter squash) and then sell it? No.** Although peeling and cooking will greatly reduce the microbial load, and will reduce some of the surface chemical contamination, any flooded produce - regardless of how it is processed - is still considered adulterated by the FDA and not allowed for sale. Unfortunately, because of the uncertainty as to the type and extent of microbial and chemical contaminants, further processing does not necessarily provide an assurance of safety. If there is contamination on the outside peel of the product, it would be hard to prevent some cross-contamination occurring with the flesh during the peeling process.
5. **There was a lot of water standing on my field after the storm but it was just rainwater; it did not come from a river, stream or other surface water. Can I sell my produce? Yes.** Pooled water from rainwater alone is not considered to be flood water and the produce should be OK for sale. However, if there is evidence of contamination due to significant runoff from an adjacent area where livestock, manure, or compost are kept, then the produce may be contaminated if it was in contact with the contaminated water and should not be sold for human consumption.
6. **My crop was flooded but I have tested it for bacteria after treating it with a chlorine sanitizer and the results show it is not contaminated, is it legal to sell? No.** Neither post-harvest cleansing of flooded crops, nor testing of flooded produce is accepted by FDA as a means of ensuring the safety of flooded produce for human consumption. This is partially because the produce could also be contaminated with unknown chemicals that are more difficult to test for, and partly because the microbial contaminants may not be evenly distributed throughout the field.
7. **I have a buyer that says if I provide a test showing my produce is not contaminated with E. coli he will purchase it. Can I sell it to him? No.** Produce buyers must follow the law, too. Further, E. coli is not the only contaminant of concern in flooded produce. Testing for microbial pathogens in this situation cannot ensure the safety of the produce, as there are too many pathogens that can cause food borne illness to test for feasibly. Pathogens are often deposited unevenly on fields in flood situations, and it is not possible to take enough of these tests to have any reasonable certainty that all the food is safe for sale.
8. **Can flooded produce be fed to livestock? No.** Upstream farms, sewage treatment plants, industrial plants, hazardous waste sites, etc. means that floodwaters almost always will contain contaminants which can stay on the produce and this can harm livestock health if consumed. The FDA is also concerned about residues from some contaminants being transferred to animal products for human consumption (meat, milk and eggs).
9. **Can I replant my greenhouse this fall to a crop of salad greens even though it flooded in the summer? No.** You should not replant flooded soils in greenhouses to leafy greens. There is just too much risk of microbial contamination from the soils getting onto these crops that are low to the ground. In general, you should avoid planting any crops consumed raw this fall. A reasonable way to reduce the risk of contamination would be to build raised beds at least 6



inches high, and bring in non-flooded soil/compost to fill them, then avoid cross contamination from soil in greenhouse walkways by covering them with landscape fabric or straw, etc.

10. **What about other perennial crops that were under flood waters but that I won't be harvesting until next year, such as Echinacea, burdock, or other herbs grown for their roots?** Crops that have been exposed to flooded soils are deemed adulterated by the FDA. Even though these crops will not be harvested for quite a while, that is the law. We do not know whether, or to what extent, these crops may take up pathogens or chemical contaminants. If they are internalized by crop tissues then waiting until the next season and allowing a winter to pass before harvesting will not avoid contamination of the crop.
11. **What kind of soil tests should I do before I plant again?** Biological contaminants (those that are carbon-based) will break down over time in the soil, and it is difficult to conduct meaningful tests for these due to their variety and spatial distribution. Heavy metals, however, will not break down over time, and can be tested for more easily using traditional soil sampling methods. You can contact the KSU Soil testing lab in Manhattan at 785-532-6101 or the MU Soil and Plant Testing lab in Columbia at 573-882-0623 for more information on their testing services.
12. **My field has large depositions of silt and debris. Do I need to remove this, test it, or can I till it in?** Large debris in your fields should be removed, but the silt deposited by flood water and smaller debris do not need to be removed. Soils should be allowed to dry sufficiently and then tilled to at least six inches deep before planting crops. Adding compost or other organic matter when tilling will be beneficial to the soil's biological activity, which can promote decomposition of some contaminants. To protect the soil from erosion after tilling, it is advisable to plant a cover crop, which will also stimulate biological activity. In the fall, consider planting small grains such as oats or winter rye with or without hairy vetch for adding nitrogen.
13. **Should I test my water?** If your wellhead was submerged under flood water, your well water should be retested to ensure that it is potable. Only potable water should be used to wash produce after harvest. In Kansas, you can contact either your local health department, a local sanitarian, or a Kansas Department of Health and Environment District Office for assistance and before collecting any well samples. In Missouri, contact the State Public Health Lab. Private certified labs are also available for water testing.
14. **What precautions should I take during clean-up?** Workers should wear protective clothing such as rubber boots, rubber gloves and an N-95 respirator mask when working in fields that were flooded. Mark the highest locations that flood waters reached using flags, etc. FDA recommends leaving a 30 foot buffer between

flooded areas of fields and areas with crops to be harvested for human consumption; this is to accommodate a generous turn-around distance for equipment to prevent crop contact with flooded soil to avoid cross-contamination. Try to minimize dust and tracking dirt and sediment from flooded areas into non-flooded areas (such as packing sheds) as much as possible to reduce the chances of cross-contamination.

15. **My fields sometimes flood in the spring, but some springs they don't. Now that I know I have to destroy flooded crops - what should I plant in areas that are likely to flood? I don't want good land that may or may not flood go to waste.** Avoid planting root crops, leafy greens and any other crops that are ready-to-eat (normally not cooked) and any crops that grow very close to the ground. Instead, consider planting taller crops such as sunflowers or sweet corn or even fruit trees; non-edible cash crops such as biofuel crops: corn, sunflowers, or canola are an option if you have the equipment to harvest them and necessary processing equipment and a market to sell them.
16. **How does flooding affect the organic certification of my land?** You will need to discuss this with your organic certifier. The organic regulations require that "prohibited substances" cannot be applied to land for at least three years prior to harvesting an organic crop. Floodwaters could contain many potential contaminants that would be considered "prohibited substances". Fortunately, the volume of water during flooding events often dilutes the contaminants. In most cases, low levels of contaminants would be considered unavoidable residual environmental contaminants and would not affect the certification of the land. However, there are instances where prohibited residues would be of greater concern and farmers should contact their organic certifier to discuss next steps. If your farm is directly downstream from a source of concentrated prohibited substances, for example, a sewage treatment facility, or if there is evidence of contamination, for example an oily residue on your fields or an empty propane tank, the organic certifier may decide to test for likely contaminants and continued certification of the affected field will be based on the outcome of the tests and on-site inspection. Note that if your wellhead was submerged, your water should be retested to ensure that it is potable. Only potable water should be used to wash organic produce. You will need to provide your organic certifier with a copy of your completed water test.

Where the FDA does not give clear guidance

Choosing to harvest crops under the following conditions appears to be allowed by the FDA but there is still a risk of contamination. It is up to the grower to decide if the level of risk is low enough to grow and harvest food crops. No one wants to be responsible for making anyone ill. Growers should



carefully consider the level of risk associated with harvesting a crop near flooded areas or one that is grown in flooded soils after the waters recede. A food borne illness event associated with Kansas or Missouri produce and even the potential lack of consumer confidence from the uncertainty of the safety of potentially flooded produce would have serious ramifications for growers throughout both states. If you do choose to harvest crops in situations described below, keep records of what factors you considered when making that decision and the steps you took to avoid cross-contamination.

17. If the edible portion of a crop was above the flood water can it be sold?

Yes, but only if the risk is low. Growers will have to make their own case-by-case analysis of this situation. (See the FDA's notice to growers about the safety of food affected by hurricanes and flooding).

Although the edible portion of the plant may not have been in direct contact with flood water, there is still risk of it becoming contaminated. Contaminants that remain on the stem can be transferred to the flower or fruit, or contaminants in the soil may be splashed up onto the fruit. The risk of cross-contamination through indirect sources is of particular concern in that the produce can become contaminated during the harvest or post-harvest handling process if it comes in contact with contaminated water, soil on hands, or other contact surfaces. Because fruits and vegetables have irregular surfaces, once contaminants become attached to the cracks and crevices on the surface of produce, it is not considered possible to disinfect the edible portion.

Questions to consider to assess the level of risk include:

- a. Are you confident that there are no major sources of contamination upstream (see description below for how to assess sources of contamination)?
- b. Were the flood waters only a few inches up on the plant and the plant is tall (For example, sweet corn, tall staked tomatoes, tree fruit and other crops where the edible portion is high on the plant and could be well above flood water even though the soil surface was flooded)?
- c. Is there is any evidence of splashing of flood water onto the crop?

18. How can I determine if there were sources of contamination upstream of my field(s)? To assess potential upstream sources of contamination, several things should be considered such as the location of malfunctioning wastewater treatment facilities, manure storages, potentially damaged septic systems, or hazardous waste sites in the watershed upstream of your farm.

19. If the edible portion of a crop had not yet formed, can I leave the flooded crop in place and sell it later? This may be possible for some crops. If soils were flooded, edible portions will be developing in the window where pathogens might still be present (some

can persist in the soil or on plants for months) and the risk of cross-contamination occurring during harvesting or handling is still there. The risks of food borne illness are greatest with any crops that might be eaten raw. With potatoes and winter squashes: if the edible part had not formed but there is reason to suspect the soil is contaminated and the edible portion of the crop will eventually come in contact with the soil once it appears, then the FDA is clear that the product should not be harvested and consumed. However, these crops, because they are cooked by consumers, have less risk than other types of crops that will be allowed to develop after a flood. Questions to consider when evaluating the crop can include: upstream sources of potential contamination, the time it took flood waters to recede, time it took the field to dry out, and the time until harvest. In general, the longer that the crop has been exposed to the sun and drying conditions, the better.

Fruiting plants that were in contact with flood waters but had no fruit on them at the time (tomatoes, beans, peas, peppers, etc.) or other plants with edible portions that had not yet formed at the time of flooding (broccoli, cabbage, Brussels sprouts etc.), may be allowed to form the edible part and then harvested after you have considered the above questions. However, do not sell these crops if the heads had started to form prior to the flood and were exposed to flood water as contaminants can get trapped within the folds of the heads and persist.

Kale and similar crops that can regrow new edible portions after flooding may be harvested if all leaves that might have come in contact with the flood waters are removed and then new growth that is harvested is triple washed and rinsed with a disinfectant (see below for information on how to disinfect produce). Keep in mind however, that sanitizer in the wash water will not remove the contaminants once they have attached to the produce.

All crops harvested as described above should be triple washed using a disinfectant prior to sale, even if you do not normally wash them.

20. I have parsley growing on black plastic that was flooded. If I mow off the plants and allow them to regrow is it OK to harvest and sell them? Only if you are sure that the parsley has not come in contact with flooded soil. In other words, the plastic must not have flooded soil or sediment remaining on top of it, and the holes in the plastic must be small enough to prevent soil splashing up during rain, etc. Parsley, cilantro and other herbs grow low to the ground and have a lot of leaf surface area to which soil can cling. If you have any doubt about soil getting onto the parsley leaves, then the crop should not be sold, especially since it is often eaten raw. Cilantro, which has a similar growth form to parsley, has tested positive in the past for pathogenic E. coli on tests conducted by the UD-SA-AMS Microbiological Data Program.



21. **I had flood water come into the wheel tracks of my field but the raised beds of crops/hills of potatoes were above the flood level, can I sell my produce?**

It depends. Above ground crops that did not contact the water can be sold. Water permeates the soil in a fan shape and could move from the wheel tracks into some parts of the raised beds, potentially contacting the potatoes. If any edible portion of root crops or crops that lie on the surface (e.g. melons) came in contact with contaminated flood water or soil that could be contaminated, that would prohibit their sale.

22. **How should I treat the crops that did not come in contact with flood water?** If a crop is anywhere near flooded soils, take extra precautions to avoid cross contamination from soil contact, blowing dust, and equipment such as dirty bins. After harvest, thoroughly rinse off any soil on the produce with potable water, and then triple rinse (i.e. put through three separate baths) in a solution of 150 ppm chlorine (sodium hypochlorite), or Sanidate® at the highest labeled rate (0.5 fl. oz/10 gal. water). Rinsing in water with disinfectant will not disinfect produce if the pathogens have already been internalized in the produce or have attached to the surface of the fruit or vegetable. The purpose of disinfectant in rinse water is to reduce the microbial load in the water to avoid cross-contamination. Disinfectants must be used properly to be effective. Excess organic matter and soil in the wash water, or an improper pH of the wash water will reduce the efficacy of the disinfectant.

- If you are using chlorine, check the wash water pH with pH test strips and adjust the pH to between 6 and 7.
- If washing tomatoes, peppers or eggplants, etc. the temperature of the water should be no more than 10 degrees cooler than the produce to prevent the crop drawing in water, potentially contaminating the flesh.
- Use test strips to monitor the level of the disinfectant often. Test strips for pH and Chlorine levels (one option)

23. **When can I replant my flooded field to edible crops?** It is up to the farmer to decide when the risk is low enough to replant. The following can help reduce risk when replanting: allow the soil to dry out, till thoroughly, and allow some time for the population of microbial pathogens to decline before planting the next human food crop. The longer you can wait, the better, and it is not advisable to plant without a waiting period. Keep in mind that the USDA GAPs food safety practices as well as the organic standards require waiting several months after the application of raw manure, and if your fields were exposed to raw manure or feces in flood waters then that can be considered a similar situation. A minimum of several weeks waiting before planting is a good idea given that some research studies have found that pathogens in soil may decline signifi-

cantly during this time. But again, if a high level of biological or chemical contaminants is suspected, as with extreme flooding conditions that breached many septic systems, it is prudent to wait longer to allow time for the carbon-based contaminants to be decomposed. Current industry guidance recommends 60 days, with shorter times possible based on the growers assessment of their field and flood conditions. Mixing in well-made compost will help stimulate biological activity and decomposition. Where you can, it will further reduce risk to sow a cover crop such as oats or winter rye and wait to plant human food crops until the following season.

24. **What kinds of edible crops can I replant on soils that have been recently flooded?** Avoid planting any leafy greens, carrots, and other crops that might be eaten raw, directly into flooded soils. These crops pose a relatively high risk, as described above. If you have greenhouses or high tunnels that you normally use for growing such crops, an alternative would be to build raised beds at least 6 inches high and fill them with soil and compost that has not been flooded. With garlic and root crops for next year's harvest it is still a good idea to wait as long as possible to plant these crops, allowing microbial pathogen populations to decline, since there is some evidence that crops can internalize pathogens from the soil. While microbial pathogens will decline over time, keep in mind that chemical contaminants may persist.

25. **Can I use wooden bins that have been in contact with flood water to store unflooded produce?** It is not advisable, as wooden bins have porous surfaces that can retain soil and harbor microbes; this creates concern about cross-contamination from contact between clean produce and contaminants that may be on the surface of the bins. However, to greatly reduce risk, you can insert a clean poly bin liner after power washing the wooden surfaces and sanitizing with a 150 ppm chlorine solution. Bin liners are available from several companies that sell harvest supplies.

This information was compiled in 2011 by: Ginger Nickerson, Vern Grubinger, Londa Nwadike and Lynn Blevins. Frequently Asked Questions about Handling Flooded Produce, University of Vermont.

Updated by: Londa Nwadike, Ph.D. Frequently Asked Questions about Handling Flooded Produce, Kansas State University.

Virus caught early on greenhouse tomatoes

By James Quinn and Patti Hosack (Director of Plant Diagnostic Clinic)

One of the challenges on detecting plants that get a virus is noticing the symptoms early. A grower in Morgan County noticed plants randomly scattered around his greenhouse were not growing normally. They plants had symptoms that might be considered a physiological disorder, a nutritional imbalance, a foliar disease or even a combination of these (see Photos 1 and 2). The plants were tested using an immunostrip assay (Agdia: Elkhart, IN) and were positive for Tomato Spotted Wilt Virus (TSWV). More severely infected plants would have some of the classic symptoms like fruit bumps and skin swirls (see Photo 3 and 4) or severe plant stunting and purplish foliage color.

Infected plants can't be 'cured' so had to be rogued out to lessen the spread of the disease. Other control methods are to apply insecticide to reduce thrips and eliminate weeds.

Thrips are known to vector the disease and weeds can harbor both thrips and the virus. The virus can be hosted by many types of landscape and garden plants. This link provides a long list of hosts: <https://scholarspace.manoa.hawaii.edu/bitstream/10125/5893/1/RES-078.pdf>.

Thrips are a common greenhouse pest that occur on a wide range of ornamentals. Tomato transplants are frequently raised in this environment, thus should be watched for the occurrence of thrips. If many plants get TSMV and they are scattered around the production greenhouse, it indicates that the transplants may already have had the virus or a thrips problem. Plants getting a virus infection after planting in a production greenhouse are often located in certain areas, like adjacent to open vents or in a corner where weeds weren't controlled.



Photo 1. Tomato plant is slightly stunted, somewhat yellowish and with some brownish foliar spots (bronzing). Photo by Joni Harper.



Photo 2. Tomato plant in foreground has TSWV. Photo by Joni Harper.



Photo 3. Green tomato fruit, with several circular white marks, from a plant that tested positive for TSWV. Photo by Patti Hosack.



Photo 4. Green tomato fruit, also from plant referenced above, with bumps due to TSWV. Photo by Patti Hosack.

Reporting the Brown Marmorated Stink Bug

by Jaime Pinero

The invasive Brown Marmorated Stink Bug (BMSB), *Halyomorpha halys*, [picture on the side-please cite source] is currently distributed in 43 US states and 4 Canadian provinces. It is a severe agricultural pest in 9 states (largely in the Mid-Atlantic) and a nuisance problem in 21 others.



Credit: Steven Valley, Oregon Department of Agriculture, Bugwood.org

BMSB is considered to be a landscape-level threat. This means that adults frequently switch between cropped land (agronomic crops, fruits, vegetables, ornamentals) and wooded habitats. This article provides an update on monitoring and management of BMSB in specialty crops. Information provided here is summarized. The STOP Brown Marmorated Stink Bug website (<http://www.stopbmsb.org>) has been setup to provide current and relevant information on this pest.

BMSB has been reported to be in Missouri since 2013. While BMSB does not seem to have reached damaging populations yet, numbers have been increasing year by year as a result of breeding populations reported in Ferguson / St. Louis area in 2015, and the continued risk posed by dissemination via hitchhiking on vehicles. Therefore, farmers of specialty crops are encouraged to monitor for this invasive pest, especially if you live in St. Louis, Springfield, and Kansas City areas.

Where does BMSB spend the winter?

During the winter months BMSB enters a type of hibernation called diapause. During this time they do not feed and do not reproduce. Overwintering takes place in forested areas as well as inside houses and other buildings. In the spring, BMSB adults emerge from overwintering sites (houses, barns, storage buildings, and dead trees) and become active on nearby crops during warm sunny days. In the spring and throughout the summer, adults feed, mate, and lay eggs.

Agricultural crops being attacked by BMSB

Both adults and nymphs (immature stages) are known to cause feeding damage to crops. BMSB has a wide host range of over 300 plants. BMSB nymphs and adults feed by inserting their piercing-sucking mouthparts into fruit, nuts, seed pods, buds, leaves, and stems and appear to prefer plants bearing reproductive structures. Their mouthparts can penetrate very hard and thick tissue, such as the hazelnut hull. Feeding damage has been recorded in high value specialty crops including tree fruit (apples, peaches, pears), small fruit (e.g., raspberries, blackberries), vegetables such as tomatoes, sweet peppers, sweet corn, as well as agronomic crops such as soybeans (Fig. 2). In one study, researchers in the Mid-Atlantic reported that sweet corn, okra, and bell pepper had significant higher abundances of BMSB adults and nymphs compared with green bean, eggplant, and tomato.

If you find a stink bug you suspect is a BMSB

First, capture it in a jar or suitable container. Put a few small holes in the lid & store in a cool location. You could also place in a plastic bag or similar and freeze it. Contact your local Extension representative (MU or LU) or the Missouri Department of Agriculture.

WHO'S WHO

MU Extension

James Quinn
Editor
573-634-2824
quinnja@missouri.edu

Dave Trinklein
State Floriculture Specialist
573-882-9631
trinkleind@missouri.edu

Amy Hess
MU IPM Program
Media Specialist
573-884-6361
hessa@missouri.edu

LU Extension

Touria Eaton
State Floriculture Specialist
573-681-5174
eatont@lincolnu.edu

Jaime Pinero
State IPM Specialist
573-681-5522
pineroj@lincolnu.edu

Zelalem Mersha
Plant Pathologist
573-681-5522
mershaz@lincolnu.edu

MU Extension County Specialists

Adair: Jennifer Schutter
660-665-9866

Daviess: Tim Baker
660-663-3232

Greene: Pat Byers
417-881-8909

Henry: Travis Harper
660-885-5556

Morgan: Joni Harper
573-378-5358

Vernon: Pat Miller
417-448-2560

Webster: Bob Schultheis
417-859-2044



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